

Rudder fin

The invention relates to a fin for a rudder for water vehicles, in particular ships, which have high demands with respect to their maneuverability. "High demands with respect to their maneuverability" refers below to ships, for which particularly high rudder forces are required and/or ships that must perform maneuvers at slow speeds such as docking maneuvers, without additional assistance, e.g. from tugboats.

Rudders with these types of fins are also called "fin rudders" or "flap rudders". These concern mostly so-called "full spade rudders", on the trailing edge of which, i.e. on the rear rudder rail as seen from the direction of ship travel, a moveable and/or pivotable fin is fastened by means of suitable fastening means, e.g. hinges or the like. As a general rule, however, these types of moveable fins can also be used in other rudder types, for example in semi-spade rudders or in rudders mounted in the sole piece.

The fin is normally designed articulated on the rudder blade of the rudder, wherein the articulation of the fin can be specified by means of an articulation device arranged between the ship hull and fin. These types of rudders are frequently designed forcibly controlled such that the fin is also articulated during the rolling of the wheel, i.e. during the pivoting of the rudder around the rudder stock axis. A greater propeller stream deflection and higher rudder forces can be achieved hereby with fin rudders so that improved maneuverability results compared to conventional rudders. The fin should thus be connected in a pivotable manner with the rudder blade of the main rudder, normally by means of hinges or the like, and is normally pivotable in the installed state around a vertical axis and/or around an axis parallel to the trailing edge of the rudder blade.

The fins are normally designed such that they have a height similar to that of the rudder blade and a length as seen in the ship's direction of travel of approx. $1/3$ to $1/10$ of the rudder blade length. Thus, fins for large ships like container ships or tankers, in which the rudder blade surface is frequently 80 m^2 and more, can reach an appropriately large size. Since rudder fins in general as well as rudder blades are made of metal in particular of steel, the rudder fins for large ships have a correspondingly high weight.

Fig. 1 shows an example of a perspective view of a full spade rudder 100 with a pivotable fin 30 known from the state of the art. The rudder shown in Fig. 1 comprises a rudder blade 20, which can be pivoted around a rudder stock 21, which should be connected with a steering gear (not shown here) arranged in a ship's hull. A pivotable and positively driven fin 30 mainly made of metal, which is provided with an articulation device 10 designed as a sliding pivoting piston linkage, is provided on the rear trailing edge of the rudder blade 20 as seen from the direction of travel. The articulation device 10 is arranged on the upper end area of the fin 30 as well as on the lower end of the skeg as a permanent component of the ship structure (not shown) and comprises a universal joint with a hinge pin 14 and the bearing housings 12 and 16 of associated horizontal pistons and vertical pistons (not shown here). It is recognizable that the articulation device 10 is arranged outside of the rudder fin and/or the rudder blade 20 of the rudder fin 30. The fin 30 progresses over the entire height of the rudder blade 20 and is arranged in a pivotable manner around the trailing edge 22 of the rudder blade 20.

It is generally advantageous to design the rudder and/or rudder fins in the lightest possible manner in order to have to apply less force during the rolling of the wheel, to be able to dimension the bearing of the rudder in a correspondingly smaller manner, etc. On the other hand, however, extremely high rudder forces occur in the case of rudder fins which are

due to the fact that the the rudder fin has a larger angle to the propeller flow than the rudder blade. Extremely high forces occur in particular in the connection area between the rudder fin and the rudder blade so that the material, from which the rudder fin is made, must be designed in an appropriately rigid and stable manner.

The object of the present invention is to specify a fin for a rudder for water vehicles, which has improved properties, in particular a reduced weight and simultaneously sufficient stability with respect to the rudder forces acting on the rudder fin, compared to the rudder fins known from the state of the art.

The object based on the invention is solved through a rudder fin with the characteristics of claim 1.

In the case of the present invention, the rudder fin has a fiber-composite material. It is hereby advantageous that through the production and/or manufacturing of the rudder fin, at least partially, using fiber-composite material, the weight of the rudder fin is considerably reduced and can simultaneously reach a sufficient stability and/or bending and connection rigidity of the rudder fin. In particular a carbon fiber composite material is advantageously used. Fiber-composite plastics and other fiber-composite materials can also be used. In particular graphite fibers can be used as carbon fibers. The advantage of the use of fiber-composite materials is their low weight and their high rigidity and stability. The use of fiber-composite material for the production of the rudder fin, on which extremely high rudder forces act, was attempted for the first time with the present invention.

It is generally advantageous to make the fin as large as possible, i.e. for the most part and/or mainly, of fiber-composite material. It is also possible that the fin be entirely made of fiber-composite material. The larger the

share of fiber-composite material in the rudder fin, the stronger the advantageous achieved hereby, e.g.:

- The bearing of the rudder can be dimensioned smaller.
- The assembly and/or the maintenance of the rudder fin is simplified.
- The production of the fin and the adjustment to the rudder blade is simplified.

In a preferred embodiment of the invention, the fin has a fin body, which is at least partially made of fiber-composite material. The fin body is thereby designed such that it forms the matrix and/or the skeleton of the fin. In particular, the fin body should advantageously be designed to receive the forces fed to the rudder fin during operation. The fin body is preferably made to the greatest extent possible out of a fiber-composite material so that the fin body is particularly preferably made mainly of a fiber-composite material. It is also possible that the fin body be made entirely of a fiber-composite material. The higher the share of fiber-composite material on the fin body, the greater the achieved weight reduction, since the fin body of rudder fins is normally, conventionally made of metal. The fin body is usually designed such that it can receive the forces acting on the rudder fin. Accordingly, it must have sufficient stability and/or rigidity, which is provided when it is made of a fiber-composite material.

Furthermore, it is preferred that the fin body mainly, preferably completely, forms the outer surface of the rudder fin. Thus, in the case of this embodiment, the fin body includes the lateral surfaces of the rudder fin, the front leading edge, the rear trailing edge and the upper and lower end areas of the rudder fin. If applicable, additional, suitable material layers such as protective paint or the like can be applied to the surface of the

rudder fin made of fiber-composite material. In this embodiment, the fin body thus forms a mainly closed main body, which forms the rudder fin.

In particular in the case of the exemplary embodiment described above, it is advantageous that the fin body forms one or more inner hollow areas separated from each other. These hollow areas can advantageously be filled in with a suitable filler material, in particular a foam-like material like high-strength and water-tight foams. The rudder fin does not thereby need to be designed as a massive body, which continues to be advantageous for the weight reduction of the rudder fin. At the same time, the fin body is designed such that sufficient stability and/or rigidity of the rudder fin is created. The filling of the hollow area(s) with a filler material serves as a further support of the fin body. In the case of this exemplary embodiment, the rudder fin could for example be made of a fin body made of fiber-reinforced plastic and a foam core made of PU foam or the like and would thus make due entirely without components and/or parts made of metal.

It is furthermore preferred that the fin body comprises a front leading edge facing a rudder as well as a rear trailing edge facing away from a rudder, wherein stiffening elements, in particular intermediate floors, are arranged between the two edges. Also in the case of this embodiment, in particular the outer surface of the rudder fin can mainly be formed from the fin body. The stiffening elements serve to reinforce and/or increase the load-bearing capacity of the rudder fin and can generally be designed in any suitable form. It is particularly preferred to design these stiffening elements as intermediate floors, which are also preferably made of fiber-composite material. These intermediate floors divide the inner hollow area of the fin body into individual bottom hollow areas and/or subsections, which can each be provided with a foam core. However, another design of the stiffening elements is also generally conceivable, for example as braces or the like.

In another preferred embodiment, the fin has one or more receiving/joint elements, which are designed for connection with a rudder and/or for the receiving of parts of a rudder. Since the rudder fin is generally arranged in an articulatable manner on the rudder blade of the main rudder, a pivotable connection must be provided between the rudder blade and the rudder fin and an articulation device or the like. The receiving/joint elements are provided for the fin-side reception of these components and/or the establishment of the connection. Thus, a receiving/joint element e.g. for receiving a component of the articulation device normally arranged on the upper rudder blade area, e.g. a sliding pivoting piston, can be designed. Alternatively or additionally, the receiving/joint elements can be part of a hinge connection or the like between the rudder fin and the rudder blade, wherein the receiving/joint element in this case can be designed as a hinge receiving and as a hinge itself.

In order to enable a connection with the rudder, or in order to be able to receive the rudder components, it is advantageous to arrange the receiving/joint elements in the area of the front leading edge of the rudder fin and/or in the upper end area of the fin. Furthermore, the receiving/joint elements are preferably designed within the fin body of the rudder fin and/or integrated into the fin body. For one, this advantageously facilitates the production process of the rudder fin, and also ensures that the receiving/joint elements are located in the area of the greatest stability of the rudder fin, namely in the fin body, since the largest forces typically occur in the connection area between the rudder fin and the rudder blade.

The receiving/joint elements can generally be made of any suitable material, in particular also a fiber-composite material or a combination of several different materials. However, it is preferred to design the receiving/joint elements out of a metallic material, in particular steel. Since high forces occur in the area of the receiving/joint elements, as already mentioned, and/or steel is particularly suitable as a bearing material, the

elements are advantageously made of metal and/or steel. However, any other suitable, sufficiently strong and stable material can also generally be used. If the receiving/joint elements are made of steel with an integrative arrangement in the fin body, the fin body will continue to be seen as mainly made of fiber-composite material when the rest of the fin body is made of fiber-composite material within the framework of the present invention.

The design of the receiving/joint elements made of steel material advantageously offers the possibility of processing them in a finished size on relatively small machine tools before the production of the fin body. The receiving/joint elements can be aligned using a suitable device, in order to then produce the fin body around the arrangement. The otherwise conventional and comparatively complicated mechanical processing of the receiving/joint elements after production of a fin body in a conventional steel construction is thus omitted.

The receiving/joint elements can generally have any suitable form. In another preferred embodiment, the receiving/joint elements are designed as tubes and/or as a combination of several tubes. The fibers of the fiber-composite material can preferably be wound around these tubes in order to produce the rudder fin. The tubes can thereby be used as a wound core, around which the fibers are wound for the production of the fin body and which remains in the component, i.e. in the fin body, after completion of the winding. Such receiving/joint elements designed as tubes are suitable in particular for receiving sliding pivoting pistons from articulation devices and/or for receiving hinge pins from hinges of rudder blades. Furthermore, the stability and/or rigidity of the fin body can increase in the case of an integrative arrangement.

Since the greatest forces act on the rudder fin in particular in the connection area between the rudder fin and the rudder blade in general

and the rudder fin is normally connected in a pivotable manner with the rudder blade in the area of its front leading edge, it is advantageous to design the fin body in a reinforced manner in the area of the front leading edge. This can be achieved for example through the provision of reinforcement layers of fiber-composite material or an overall thicker design of the fin body in the front edge area compared to the other area of the fin body.

In another preferred embodiment, the fin body has a maximum length of 15 to 50%, preferably 20 to 40%, of the maximum length of the fin in a cross-sectional view in the area of the front leading edge. It was determined that in the case of such length ratios optimal results can be achieved with respect to sufficient stability and/or rigidity of the rudder fin with simultaneously maximum weight reduction. The maximum length of the fin body is thereby advantageously provided in the area of the pivot connections of the rudder fin with the rudder blade, in particular in the area of the uppermost pivot connection.

Production in a fiber-composite construction generally enables a simpler implementation of complex geometries and/or bent, profiled surfaces than is possible with steel constructions. A hydrodynamically more beneficial profile with less flow resistance can be simultaneously realized especially in the upper end area, on which the articulation is located, through a geometrically optimally modified design.

Furthermore, the object on which the invention is based is solved through a method for the production of a fin of a rudder for water vehicles, in particular for ships with high demands with respect to their maneuverability, in which a fin body is produced, which mainly consists of a fiber-composite material, mainly forms the outer surface of the fin and has at least one hollow space. By making the fin body out of a fiber-composite material, considerable weight reduction can be achieved with

simultaneous guarantee of sufficient rigidity of the rudder fin. The provision of a hollow area instead of the design of a massive body further contributes to the weight reduction of the rudder fin. One or more receiving/joint elements can preferably be provided on the fin body, which are designed for the connection with a rudder and/or for receiving parts of a rudder. Furthermore, the at least one hollow area can be filled with a filler material.

For the production of the fin body, which is at least mostly made of a fiber-composite material, any suitable production process known from the state of the art can generally be used for fiber-composite materials. In a preferred embodiment of the method according to the invention, two half shells, which are combined together into the fin body, are produced for the production of the fin body. Furthermore, stiffening elements, in particular intermediate floors, can advantageously be used, which are positioned between the two half shells before the joining and are arranged within the two half shells and thus in the hollow area of the fin body after the joining. In an alternative embodiment, foam cores are provided, around which the fin body made of fiber-composite material is wound. A winding around the receiving/joint elements can also advantageously take place. Alternatively or additionally, layers and/or mats of fiber-composite material, can be laminated, in particular manually, onto the cores and/or the receiving/joint elements. In contrast to this, the fiber winding is generally performed mechanically. With this method, qualitatively high-quality and in particular extremely economical fins and/or fin bodies in particular in the case of small numbers can be produced since this method requires no initial investment for half shell molds.

A preferred embodiment of the invention is shown in the drawing. The drawings schematically show in:

- Fig. 1 a perspective view of a spade rudder with a fin known from the state of the art;
- Fig. 2 a perspective side view of a rudder fin according to the invention;
- Fig. 3a a side view of the rudder fin from Fig. 2;
- Fig. 3b a top view of the rudder fin from Fig. 2;
- Fig. 4a a sectional view of the rudder fin from Fig. 3b;
- Fig. 4b1 a sectional view of the rudder fin from Fig. 3a;
- Fig. 4b2 an enlargement of a section from Fig. 4b1;
- Fig. 4c another sectional view of the rudder fin from Fig. 3a;
- Fig. 4d another sectional view of the rudder fin from Fig. 3a;
- Fig. 4e another sectional view of the rudder fin from Fig. 3a;
- Fig. 4f another sectional view of the rudder fin from Fig. 3a;
- Fig. 4g another sectional view of the rudder fin from Fig. 3a;
- Fig. 5a a perspective representation of a receiving/joint element;
- Fig. 5b a perspective representation of another receiving/joint element; and
- Fig. 5c a perspective representation of another receiving/joint element.

Fig. 2 shows a fin 40 according to the invention, which is designed for pivotable articulation on a rudder blade of a rudder for water vehicles. Covered or internal parts of the fin 40 are shown using dashed lines in the representation of Fig. 2. Thus, the fin 40 comprises a front leading edge 41, a rear trailing edge 42, an upper end area 43 and a lower end area 44. The fin 40 is formed by a fin body made of a fiber-composite material, which comprises all fin material in the area of the front leading edge 41, the trailing edge 42, of the upper end area 43 and of the lower end area 44. Moreover, the fin body comprises side walls and/or side surfaces 45 and several intermediate floors 46 arranged between the two edges 41, 42 and the side walls 45. The intermediate floors 46 divide the hollow area arranged between the edges 41, 42 of the two end areas 43, 44 and the

side walls 45 of the fin body into several, separate hollow areas 47. These hollow areas are preferably filled with a foam core (not shown here). An upper recess 48a and a lower recess 48b are provided in the area of the front leading edge 41 of the fin 40. Furthermore, a steel tube 70 is provided between both recesses 48a, 48b and parallel to the longitudinal axis of the fin 40 in the fin body in the area of the front leading edge 41. Another steel tube 80 parallel to the longitudinal axis is provided in the fin body between the lower recess 48b and the lower end area 44. Another relatively short steel tube 91, which is connected with another longer steel tube 92 mainly arranged orthogonally to it, is provided above the upper recess 48a. The steel tube 92 runs diagonal to the longitudinal direction of the fin 40 through the upper end area 43. Together with the recesses 48a, 48b, the steel tubes 91, 70 and 80 form two receiving/joint elements for pivotable connection with a rudder blade. The receiving/joint elements of the frontal edge area of the fin 40 shown here and consisting of tubes 70, 80, 91 and recesses 48a, 48b are designed in particular for receiving hinge pins of hinges of a rudder blade. The hinge pins (not shown here) can each be inserted into the end areas of the tubes 70, 80, 91 which are open towards the recesses 48a, 48b, while the hinge component (not shown here) of the rudder blade arranged around the hinge pins can be inserted into the respective recess 48a, 48b. All tubes 70, 80, 91, 92 are fully arranged within the fin body of the rudder fin 40 and/or are designed integrated into it. The tube 92 is another receiving/joint element and is designed for receiving a part of an articulation device, in particular of a sliding pivoting piston, of a rudder blade (not shown here). The piston can be inserted through the tube 92 and thus serves to forcibly articulate the fin 40 on a rudder blade of a rudder for water vehicles. In contrast to the fins known from the state of the art and for example shown in Fig. 1, the receiving/joint element 92 of the rudder fin 40 according to the invention is designed in the fin body of the fin 40 and/or is integrated into it and is not fitted on the upper end area 43 of a fin 40 like usual. The structure of the

rudder fin is hereby simplified and no separate components need to be installed on the fin 40.

Fig. 3a shows a side view of the rudder fin 40 from Fig. 2. In contrast, Fig. 3b shows a top view of the same fin 40. Fig. 4a through 4g show different sectional representations of the fin from Fig. 2, 3a and 3b. Thus, Fig. 4a shows a longitudinal sectional view through the fin 40. All hatched, cut surfaces in Fig. 4a represent the fin body of the fin 40, made of fiber-composite material, into which the tubes 70, 80, 91, 92 of the receiving/joint elements are integrated. The intermediate floors 46 are arranged parallel to each other and divide the inner area of the fin body of the fin 40 into several separate hollow areas 47, which are preferably filled with a foam core. Furthermore, it is recognizable that the entire fin is made of the fin body made of fiber-composite material, the tubes 70, 80, 91, 92 integrated into the fin body and if applicable the foam cores (not shown here) arranged in the hollow areas 47. Furthermore, it is recognizable that the frontal edge 41 in the area of the upper recess 48a is designed reinforced, i.e. thicker than shown in the other area, since high loads occur here. The outside of the frontal edge 41 is designed mainly linear, just like the outsides of the upper and lower end area 43, 44. In contrast, the outside of the trailing edge 42 has a flat, curved and/or convex progression, wherein the greatest width of the fin 40 is designed in the upper end area 43. The tubes 70, 80, 91 and 92 serve for one to receive components of a rudder. On the other hand, however, they also reinforce the respective areas of the fin body, in which they are arranged, namely the frontal edge area 41 and the upper end area 43.

Fig. 4b1 shows a longitudinal sectional view through the rudder fin 40 turned by 90° with respect to the longitudinal sectional view from Fig. 4a. Fig. 4b2 is an enlargement of the upper end area 43 of Fig. 4b1. It is recognizable that the tube 92 is completely surrounded and/or encased by the fiber-composite material of the fin body in the upper end area 43 of the

rudder fin 40. Thus, the entire outer surface of the rudder fin 40 is formed by the fin body made of fiber-composite material.

In contrast, Fig. 4c through 4g show different cross-sectional representations of the rudder fin from Fig. 2, 3a and 3b respectively. Fig. 4c shows a cross-sectional view through the rudder fin 40 in the area between the tube 92 and the uppermost hollow area 47. Thus, the cross-section proceeds along the intersecting line C-C holohedrally through the fin body. Accordingly, Fig. 4c shows a holohedral surface made of fiber-composite material, which is only interrupted by the recess of the tube 91. From the frontal edge 41, the profile of the fin extends in a half-circle-like manner to an area of the largest profile width, which is arranged at the height of tube 91. From there, the walls 45 run approximately parallel until they taper in a curved manner up to a trailing edge 42 after approximately more than half the length of the rudder fin.

Fig. 4d shows a sectional view through an intermediate floor 46, which is arranged behind the recess 48a when seen from the longitudinal direction. It is recognizable that the intermediate floor 46 is designed integrated into the walls 45 and the trailing edge 42.

Fig. 4e shows another cross-sectional view, which runs through a hollow area 47. It is recognizable that the length of the front end area 41 made of fiber-composite material is approx. $\frac{1}{3}$ of the overall length of the rudder fin. The hollow area 47 is designed approximately like a triangle, wherein the two long legs are curved.

Fig. 4f shows another sectional view through an intermediate floor 46 and Fig. 4g shows a sectional view through a hollow area 47 and the recess 48b.

Fig. 5a, 5b and 5c show perspective detail views of the tubes 70, 80, 91, 92 arranged integrated in the fin 40. The tube 70 has an upper end area 71, which is arranged in the area of the recess 48a and has a larger diameter with respect to the rest of tube 70. This larger diameter serves for one to reinforce the upper end area 71 and for the adjustment to the receiving of a hinge pin and a hinge of a rudder (not shown here) in the functionality of a bearing shell for the hinge pin. The tubes 91 and 92 are connected together through the formation of an almost right angel, in particular by means of welding, wherein an opening 93 is provided in tube 92 opposite tube 91. All tubes 70, 80, 91, 92 have disk-like end pieces 94 on their open ends, which come to rest on the fiber-composite material of the fin body of the fin 40. The steel tube constructions shown in Fig. 5a through 5c can also be called "inlets."

List of References

100	Rudder
10	Articulation device
12	Bearing housing
14	Hinge pins
16	Bearing housing
20	Rudder blade
21	Rudder stock
22	Trailing edge of rudder blade
30	Fin from the state of the art
40	Fin according to the invention
41	Leading edge
42	Trailing edge
43	Upper end area
44	Lower end area
45	Side wall
46	Intermediate floor
47	Hollow areas
48a,b	Recess
70	Steel tube
71	Upper end area
80	Steel tube
91	Steel tube
92	Steel tube
93	Opening
94	End pieces

Claims:

1. Fin rudder for maneuvering ships with high demands with respect to maneuverability,
comprising a rudder blade and a fin
characterized in that
the fin, which is pivotally fastened to the rudder blade, comprises a fin
body, which is at least partially made of fiber-composite material.
2. The fin rudder according to claim 1,
characterized in that
the fin body at least partially forms the outer surface of the fin.
3. The fin rudder according to claim 2,
characterized in that
the fin body has one or more separated inner hollow areas,
which are preferably filled with a filler material, in particular a foamy
material.
4. The fin rudder according to one of claims 1 through 3,
characterized in that
the fin body comprises a front leading edge facing the rudder, a rear
trailing edge facing away from the rudder and stiffening elements, in
particular intermediate floors, arranged between both edges.

5. The fin rudder according to one of claims 1 through 4,
characterized in that
the fin body is reinforced in the area of the front leading edge facing the
rudder.
6. The fin rudder according to one of claims 1 through 5,
characterized in that
in a cross-sectional view the fin body in the area of the front leading
edge has a maximum length of 15 - 50% of the maximum length of the
fin.
7. The fin rudder according to one of the previous claims,
characterized in that
the fin comprises at least one receiving/joint element for connection
with the rudder and/or for receiving a component of the rudder, which is
preferably arranged in the area of the front leading edge facing the
rudder and/or in the upper fin end area
(43).
8. The fin rudder according to claim 7,
characterized in that
the at least one receiving/joint element is made of one or more
metallic materials, in particular steel.
9. The fin rudder according to claim 7 or 8,
characterized in that
the at least one receiving/joint element comprises one or more tubes,
around which the fiber-composite material can be wound and/or
laminated.

10. The fin rudder according to any one of the preceding claims for a water vehicle, in particular for ships with high demands with respect to maneuverability.
11. The rudder according to claim 10,
characterized in that
the fin comprises at least one receiving/joint element for connection with a rudder blade and/or for receiving a component of the rudder blade, which is preferably arranged in the area of the front leading edge of the fin facing the rudder blade and/or in the upper fin end area, wherein a part of a hinge arranged on the rudder blade and designed for the pivotable connection of the fin on the rudder blade is connected with the at least one receiving/joint element of the fin and/or is inserted into the at least one receiving/joint element of the fin, and/or wherein an articulation device, in particular a sliding pivoting piston, of the rudder is connected with the at least one receiving/joint element of the fin and/or is inserted into the at least one receiving/joint element of the fin.
12. Method for the production of a fin of a rudder for water vehicles, in particular for ships with high demands with respect to maneuverability characterized in that
a fin body is made at least mainly of fiber-composite material, which forms at least mainly the outer surface of the fin and has at least one hollow area,
one or more receiving/joint elements are provided if applicable in and/or on the fin body for connection with the rudder and/or for receiving components of the rudder, and

if applicable the at least one hollow area is filled with a filler material.

13. The method according to claim 12,
characterized in that
for the production of the fin body two half shells and if applicable
stiffening elements to be arranged between the half shells are
produced and combined into the fin body.
14. The method according to claim 12,
characterized in that
for the production of the fin body one or more cores, in particular foam
cores, and/or one or more receiving/joint elements are provided,
around which the fiber-composite material is wound and/or laminated.